



# Environmental Considerations of Goods Movement

**Office:**

California Department of Transportation  
Division of Transportation Planning  
Office of System and Freight Planning

**Contact:**

Bruce Kemp, [bruce\\_kemp@dot.ca.gov](mailto:bruce_kemp@dot.ca.gov); 916-651-6006

The efficient movement of commodities is critically important to the economy and to employment in all major sectors, from agriculture to manufacturing (including finished goods, energy, construction, and retailing) to the service industries. At the same time, many aspects of freight transportation adversely affect human communities and the environment. Increasingly, federal and state mandates are recognizing that freight transportation improvements must be closely tied to environmental considerations, especially issues related to environmental justice, air quality, and greenhouse gas emissions. Freight mobility planning strives for sustainable solutions: efficient systems, strong economies, environmental protection, and healthy communities.

### IMPACT AREAS

Goods movement affects many community and environmental resources. The most prevalent issues tend to be related to air pollution, social equity, public health, energy consumption, noise, aesthetics, water quality, and climate change.

#### *Air Pollution and Diesel Emissions*

- The main transportation-related pollutants are ozone and its precursors – hydrocarbons (HC) and nitrogen oxides (NOx), carbon monoxides (CO) – and particulate matter (PM-10 or PM-2.5, particles that are smaller than 10 or 2.5 micrometers, respectively).
- Goods movement depends primarily on diesel engines in trucks, locomotives, marine vessels, and cargo handling equipment. Diesel engines emit a complex mix of pollutants, including very small carbon particles (“soot”) known as diesel PM. Diesel exhaust contains over 40 cancer-causing substances, most of which are readily adsorbed on the soot particles.
- The U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (ARB) classify pollution from diesel engines as a toxic air contaminant based on its potential to cause cancer, premature death, and other health problems. Diesel PM represents 70% of the known potential cancer risk from air toxics in California.

- In places with multiple mobile and stationary sources – such as around ports, rail yards, major heavy-duty truck routes, and airports – the adverse air quality impacts can be cumulative.

#### *Community Impacts*

- Diesel engines are a major source of health-threatening air pollutants, affecting many communities along major trade routes.
- Freight movement-related environmental impacts may particularly affect disadvantaged and low-income populations. Effects of pollution on sensitive populations (young, old, compromised health) tend to be more severe.
- Some regions of California pay a kind of “subsidy,” where others outside the region enjoy the benefits of goods movement, while the environmental burden is carried by communities located near the trade corridors.
- ARB estimates that every dollar spent on reducing freight-related pollution produces long-term health and productivity benefits valued between \$3 and \$8.
- Densely populated areas near rail yards, ports, and multimodal facilities experience high levels of air pollution, noise, and visual impacts.
- Traffic congestion and delay (with associated air quality effects) occur where drayage trucks congregate, such as near seaports, land ports of entry, distribution centers, and transfer facilities.

- Freight trains cause noise and vibration impacts while passing through a neighborhood; they also block at-grade roadway crossings causing traffic delays and impeding emergency vehicles.

### ***Biological Impacts and Water Quality***

- Harm to marine and river environments can occur directly or indirectly through dredging of rivers, bays, and estuaries.
- All transportation modes can cause direct mortality of wildlife. Transportation corridors may cause fragmentation of habitat.
- Unwanted distribution of invasive aquatic species by marine vessels can occur through the inappropriate discharge of ballast water.
- Water pollution can occur from spills, contamination, storm water runoff, dredging, chemical use, cargo handling, and inappropriate discharge.

### ***GHG Emissions and Climate Change***

- In California, the transportation sector contributes about 36% of all greenhouse gas (GHG) emissions. On-road emissions constitute 93% of that total, most of which (73%) comes from passenger vehicles. Heavy-duty trucks are responsible for 20% of the global warming pollution in the transportation sector statewide.
- Freight movement contributes approximately 8% of the total global carbon dioxide (CO<sub>2</sub>) emissions.
- Diesel soot, mixing with other pollutants, is a major global warming agent, second only to CO<sub>2</sub>.
- Goods movement infrastructure may be vulnerable to the effects of climate change, including sea level rise, coastal erosion, and temperature extremes.

### **AIR QUALITY COMPLIANCE AND CONFORMITY**

- Transportation projects in California are subject to both federal and State air quality standards. The main pollutants of concern for transportation among the “criteria pollutants” identified in the federal and State Clean Air Acts are: ozone, particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and sulfur dioxide (SO<sub>2</sub>).
- Plans for attainment and maintenance of the applicable standards are called the “State Implementation Plan” (SIP) for federal standards and the “Air Quality Attainment Plan” (AQAP) for State standards. California standards primarily affect the California Environmental Quality Act (CEQA) environmental analysis process; federal standards affect the environmental analysis process and conformity requirements.
- “Conformity” requirements, based on the federal Clean Air Act and EPA regulations, apply to regional transportation plans (RTP), transportation improvement program (TIP), and project approvals in areas that fail or formerly failed to attain federal ambient air quality standards for these pollutants.

### **MODAL CONSIDERATIONS**

All goods movement modes – heavy-duty trucks, ocean-going vessels, freight locomotives, and air cargo – are associated with environmental effects.

#### ***Trucking***

- ARB estimates approximately 100,000 drayage trucks operate statewide; nearly 20,000 frequently service ports and rail yards.
- At 300 feet downwind from an interstate freeway with truck traffic of 10,000 trucks per day, the potential cancer risk may be as high as 100 in one million.
- Proximity to pollution from heavy highway traffic is linked to health problems such as

reduced lung function and increased asthma and bronchitis.

- ARB regulations (2008) prohibit sleeper berth vehicles from idling during rest periods.

#### ***Rail Lines***

- One intermodal train can carry as much freight as 280 to 300 trucks, thus reducing congestion and air emissions if the trucking freight is shifted to rail. (Cost factors, however, often favor trucks for short to medium length trips.)
- In Southern California, railroad locomotives contribute approximately 5% to 7% of the region’s goods movement emissions.

## Freight Planning Fact Sheet

- Locomotive emissions contribute about 20 tons per day of NOx, of which approximately 70% come from line-haul freight locomotives.
- Railroad locomotives produce about 0.76 tons per day in PM2.5 emissions, of which more than 80% come from line-haul freight locomotives.
- If no additional mitigation measures are applied, the adverse effects of emissions from projected growth in freight train volume may cancel out and exceed the benefits of the cleaner (Tier 2) locomotives and low sulfur fuel standards by 2030.

### ***Marine Trade and Seaports***

- Estimated health costs from freight-related pollution at the Ports of Long Beach and Los Angeles (the San Pedro Bay Ports) in 2005 amounted to more than \$19.5 billion.
- Statewide emissions from ports and international goods movement exceed 400 tons per day for diesel PM, NOx, ROG (reactive organic gasses), and SOx (sulfur oxides).
- Ships emit diesel exhaust even when “hotelling” while at port – i.e., running engines to maintain power, air, and heat. Ports are increasingly making efforts to allow ships to plug in to electrical power (“cold ironing”).
- An ARB health impact assessment determined that diesel PM emissions from the Port of

Oakland extend nearly a half million acres, with over three million people having a potential elevated cancer risk of more than 10 chances in a million due to exposure from diesel PM emissions from port operations.

- To deduce pollution, ARB requires harbor craft in the South Coast Air Basin to use ultra-low sulfur diesel fuel having a maximum 15 parts per million sulfur, which is a much lower sulfur content than typical marine engine fuels.
- While economic benefits from the San Pedro Bay ports accrue throughout the nation, the environmental impacts of trade are more locally concentrated.

### ***Air Cargo***

- The main environmental impacts associated with airport operations (cargo or passenger) are noise, air quality, water quality, and traffic circulation.
- Ground transportation access to air cargo hubs involves high numbers of trucks.
- Air cargo aircraft operations tend to occur at night, when noise impacts are greater. Hub operations may concentrate take offs and landings as freight arrives, is processed, and then departs, resulting in waves of aircraft and ground delivery vehicles.

## **KEY ENVIRONMENTAL MANDATES IN TRANSPORTATION PLANNING**

### ***Federal***

- National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations
- Clean Air Act and Amendments of 1990; EPA regulations
- Clean Water Act, including Section 404 (regulating discharge into wetlands, waters of the U.S.)
- National Historic Preservation Act, including Section 106
- Endangered Species Act and marine mammal protection
- Rivers and Harbors Appropriations Act Section 9 (bridge permits administered by the U.S. Coast Guard) and Section 10 (construction and dredging permits administered by the Army Corps of Engineers)
- Department of Transportation Act of 1966, Section 4(f) (avoiding use of public parklands, wildlife and waterfowl refuges, recreation areas, or historic site)
- Federal-Aid Highway Act, Section 109(h) – Economic, Social and Environmental Effects
- Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) for NEPA implementation; supplements the CEQ NEPA regulations
- Transportation Efficiency Act for the 21st Century (TEA-21) and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (re-authorization is pending)

## KEY ENVIRONMENTAL MANDATES IN TRANSPORTATION PLANNING (CONT'D.)

### *State of California*

- California Environmental Quality Act (CEQA) (including 2010 amendments to address greenhouse gases)
- State Clean Air Act; Local air quality management districts' rules and regulations
- California Fish and Game Code (including Sections 1600 et seq.)
- California Endangered Species Act
- State and Regional Transportation Plans, Goods Movement Action Plan
- AB 32 – California Global Warming Solutions Act of 2006
- SB 375 – the Sustainable Communities Planning Act of 2008
- California Air Resources Board air quality regulations and voluntary agreements with railroads

## MITIGATION STRATEGIES AND TECHNOLOGICAL INNOVATIONS

### *General Strategies*

- Avoidance (e.g., separating sensitive land uses from rail yards, ports, heavy truck facilities)
- “Building in” mitigation measures (i.e., incorporating environmental benefits in design)
- Alternative modes of transportation (e.g., rail or barge instead of truck)
- Alternative fuels (“fuel-switching;” e.g., low-sulfur diesel instead of bunker fuel)
- Alternative equipment (dirty diesel engines replaced by newer, cleaner engines)
- Innovative technologies (hybrid vehicles, alternative cargo moving systems)
- Electrification of systems
- Design or operational changes (addition of soundwalls, separate truck lanes, hours of operation; congestion pricing to decrease peak container traffic flows)
- “Cap and trade” regulatory systems that establish mandatory caps on emissions while allowing flexibility in compliance, such as banking or selling allowances
- In the long term, major consumer increases in domestic and local goods to replace imports.

### *Practices and Innovations*

#### **In Operation**

- Noise-reduction walls
- Highway-rail grade separations, especially in congested areas
- Dedicated highway lanes for clean vehicles
- Truck “re-powering” (engine replacement) or retrofitting with exhaust treatment devices
- Low-sulfur fuels for marine vessels
- Idle-control mechanisms installed on locomotives

- Idle-reduction technologies – electric power supply for trucks when stopped
- Marine vessel speed reductions near the ports
- Auxiliary engines powered by cleaner fuel for marine vessels when in port
- Pollution traps on port-side equipment (Ports of Oakland, Los Angeles, and Long Beach)

#### **In Demonstration**

- Hybrid trucks
- Electric (battery-powered) locomotives
- Dockside electrical connections for ships
- EcoCrane rubber-tired gantry crane with downsized (105 HP) diesel engine that charges a battery pack (at the Port of Los Angeles)
- GenSet locomotives: a low-emission, EPA-certified, diesel-switch locomotive, with multiple, low-horsepower engines operating as needed in place of one large engine
- Tugboats with hybrid engines (at the Port of Long Beach)
- Advanced technology locomotive engine upgrades with soot traps
- Intermodal automated gate system (e.g., at the BNSF intermodal facilities in San Bernardino)
- Electric cranes that produce zero emissions while generating power lowering a load
- Electric (electromagnetic) cargo conveyors (including ECCO)

#### **Further Out**

- Zero-Emissions Container Mover System
- Dual-mode freight locomotives (battery-electric and diesel, with energy recovery)
- Hydrogen-powered trucks
- Biofuels for marine vessels
- Solar-powered marine vessels
- Maglev freight transport
- Underground vacuum tube freight movement